The Evolution and Survival of the Galápagos Medium Ground Finch

A Carolina Essentials™ Activity

Overview

This activity is a data-driven analysis lesson that uses information collected in the late 1970s by Peter and Rosemary Grant of Princeton University. The Grants collected data on medium ground finches, *Geospiza fortis*, on Daphne Major, one of the Galápagos Islands. During 1977, a drought on Daphne Major resulted in a higher than normal mortality rate for the finches. The Grants investigated finch characteristics that may have contributed to the survival of the remaining birds.

Students will use this data to construct frequency distribution graphs as evidence of the process of evolution, leading them to identify those birds that are better able to survive and reproduce during a drought period.

Life Science
Grades: 9–12

Phenomenon

Below is a stamp commemorating Darwin and the Galápagos finches he observed. How does this represent and explain the theory of evolution?

Essential Question

What kind of evidence is necessary to explain the process of evolution?

Activity Objectives

1. Create frequency distribution graphs of finch survival after drought.
2. Use distribution graphs as evidence to explain which finches are better able to survive and reproduce during drought conditions and how this relates to the process of evolution.

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TIME REQUIREMENTS

PREP	ACTIVITY
15 min	20–30 min

Teacher Prep: 15 min
Student Activity: 20–30 min

SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS (PER GROUP)

Student activity sheet with data

Graphing supplies if students are graphing by hand (graph paper, colored pencils, ruler)

HELPFUL LINKS

Examples to Use When Teaching About Selection and Evolution

A Flipped Inquiry Approach to Teaching Natural Selection

Turkeys and Their Domestication

REFERENCE KITS

Natural Selection

Evolution in Real Time: Bacteria and Antibiotic Resistance

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Next Generation Science Standards* (NGSS)

HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential of the species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaption of populations.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS4.C: Adaptation** • Evolution is a consequence of the interaction of four factors: (1) the potential of the species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. • Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Teacher Preparation and Disposal

Copy or upload the student activity page. There is no disposal of waste materials.

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Student Procedure

1. Prepare a survivablility table by year and the number of finches that survived and died.
2. Construct a frequency distribution histogram of the finch survival data.
3. To the survival data, add the average beak depth to the table.
4. Construct a frequency distribution histogram of beak depth and survival.
5. Select one of the other variables in the data table that you think may impact the survival of the finches during a drought and complete the same analysis as above. Generate a survivability data table and frequency distribution histogram.

Teacher Preparation and Tips

If these tables are new to students, go through the first table with them. See the keys below.

Students may graph by hand or use a computer program. (Excel is easy to use).

Calculations may be done by hand, calculator, or computer.

You may wish to assign the remaining variables yourself to ensure that all other variables are tested.

Data and Observations

Individual Finch Survival and Mortality Measurements

Bird ID	Death Year	Beak Depth (mm)	Weight (g)	Wing (mm)	Beak Length (mm)
1	1977	8.30	14.50	67.00	9.20
2	1977	7.50	13.50	66.00	9.50
3	1977	8.00	16.44	64.19	9.93
4	1977	10.60	18.54	67.19	11.13
5	1977	11.20	17.44	70.19	12.13
6	1977	9.10	16.34	71.19	10.63
7	1977	9.50	15.74	67.19	9.93
8	1977	10.50	16.84	68.19	11.33
9	1977	8.40	15.54	68.19	9.93
10	1977	8.60	17.50	70.00	11.10
11	1977	9.20	15.00	67.00	10.80
12	1977	8.80	17.00	70.00	9.70
13	1977	8.50	15.00	66.00	10.60
14	1977	8.00	15.00	66.00	9.60
15	1977	9.70	15.00	67.00	10.50
16	1977	8.40	16.50	67.00	9.90
17	1977	7.90	13.00	64.00	9.60

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Data and Observations (continued)

Individual Finch Survival and Mortality Measurements (continued)

Bird ID	Death Year	Beak Depth (mm)	Weight (g)	Wing (mm)	Beak Length (mm)
18	1977	9.30	16.00	71.00	10.70
19	1977	7.70	13.50	65.00	9.30
20	1977	8.50	16.00	69.00	10.10
21	1977	8.20	14.00	65.00	9.70
22	1977	9.70	15.00	65.00	11.00
23	1977	10.30	19.00	70.00	11.00
24	1977	10.20	17.00	72.00	11.60
25	1977	8.90	15.00	68.00	10.50
26	1977	9.60	16.50	68.90	10.20
27	1977	7.85	14.75	64.20	9.70
28	1977	9.60	16.00	73.00	11.10
29	1977	9.80	17.00	68.00	11.10
30	1977	8.80	15.00	68.00	10.20
31	1977	9.00	16.00	68.00	10.80
32	1977	9.10	14.50	65.00	10.00
33	1977	9.20	17.00	69.00	11.10
34	1977	8.80	16.00	70.00	10.30
35	1977	9.20	17.00	70.00	11.10
36	1977	8.80	14.50	66.00	10.50
37	1977	9.40	15.50	67.00	11.00
38	1977	8.30	14.50	67.00	10.00
39	1977	8.40	15.50	66.00	10.30
40	1977	10.20	16.50	70.00	11.70
41	1977	9.30	14.00	66.00	10.20
42	1977	10.20	15.50	71.00	10.90
43	1977	10.50	16.50	69.00	11.90
44	1977	9.00	14.00	66.00	10.20
45	1977	9.80	16.00	66.00	10.50

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Data and Observations (continued)

Individual Finch Survival and Mortality Measurements (continued)

Bird ID	Death Year	Beak Depth (mm)	Weight (g)	Wing (mm)	Beak Length (mm)
46	1977	9.30	14.00	65.00	10.50
47	1977	7.60	15.50	67.00	9.80
48	1977	10.50	18.50	70.00	11.80
49	1977	9.70	17.00	72.00	11.00
50	1977	8.60	14.00	66.00	10.30
51	1978	9.80	18.00	71.00	11.50
52	1978	8.50	14.00	67.00	10.20
53	1978	10.30	18.00	70.00	12.10
54	1978	9.90	17.50	68.00	11.60
55	1978	8.80	15.00	67.00	10.30
56	1978	10.10	18.00	72.00	11.40
57	1978	8.20	14.50	67.00	8.70
58	1978	8.00	15.00	65.00	9.90
59	1978	8.90	14.50	65.00	10.20
60	1978	9.10	15.00	66.00	10.30
61	1978	9.80	16.24	68.19	11.43
62	1978	10.10	17.34	70.19	11.93
63	1978	8.55	17.09	68.19	11.03
64	1978	9.30	17.64	72.19	10.63
65	1978	10.00	17.24	71.19	10.83
66	1978	10.70	18.04	72.19	11.23
67	1978	9.10	15.84	68.19	11.23
68	1978	8.80	15.24	65.19	10.23
69	1978	10.40	16.14	66.19	11.63
70	1978	10.70	20.19	72.69	12.23
71	1978	9.15	16.24	67.69	11.03
72	1978	11.20	21.24	72.19	11.13
73	1978	10.50	17.44	72.19	10.93

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Data and Observations (continued)

Individual Finch Survival and Mortality Measurements (continued)

Bird ID	Death Year	Beak Depth (mm)	Weight (g)	Wing (mm)	Beak Length (mm)
74	1978	9.70	16.94	70.19	11.03
75	1978	8.90	14.74	65.19	10.23
76	1978	10.10	17.34	69.19	11.33
77	1978	8.90	15.54	68.19	10.03
78	1979	9.60	19.00	70.00	10.70
79	1979	8.50	15.40	66.00	10.00
80	1979	10.08	16.34	68.01	12.43
81	1979	9.45	15.41	72.94	11.09
82	1979	8.31	15.37	67.95	9.63
83	1980	9.80	17.50	67.00	11.60
84	1980	9.70	16.50	71.00	11.30
85	1980	10.38	17.94	71.01	12.13
86	1980	10.61	21.22	71.45	12.03
87	1980	8.38	17.04	68.01	10.63
88	1980	10.78	17.74	71.01	11.83
89	1980	11.01	18.87	71.95	12.43
90	1980	10.68	18.44	74.01	12.73
91	1980	8.78	15.14	70.01	10.33
92	1980	10.28	17.84	71.01	11.03
93	1980	10.86	19.63	70.41	12.53
94	1981	11.21	20.82	70.45	12.13
95	1981	9.48	16.64	69.01	10.43
96	1981	9.86	18.07	70.95	11.23
97	1981	9.28	15.60	69.47	11.23
98	1982	9.31	16.67	69.45	10.53
99	1982	9.85	17.55	67.50	10.90
100	1982	10.00	15.00	69.00	10.50

Source: Grant, P. 1986. *Ecology and Evolution of Darwin's Finches*. Princeton University Press.

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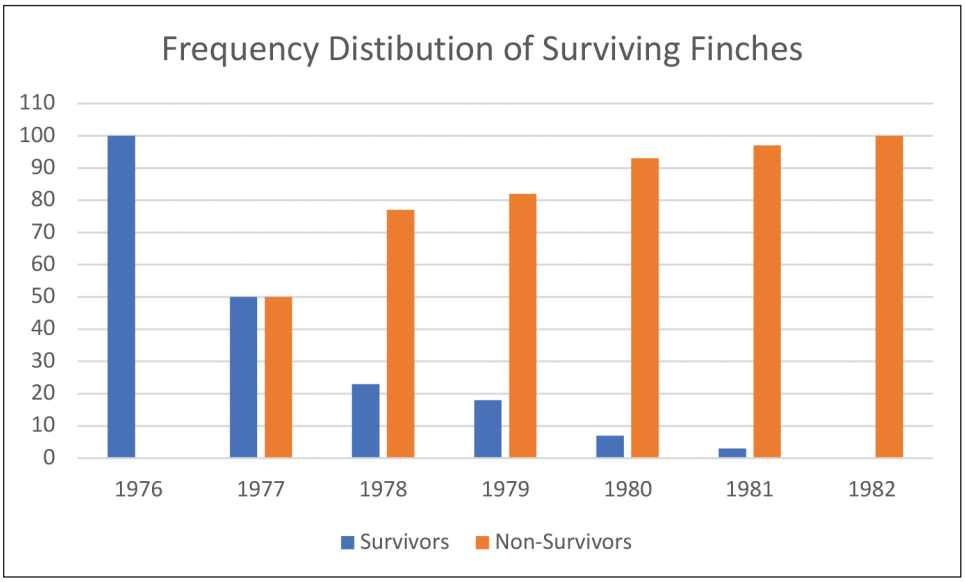
Procedure 1

Survivability

Year	Survivors	Non-Survivors
1976	100	0
1977	50	50
1978	23	77
1979	18	82
1980	7	93
1981	3	97
1982	0	100

Procedure 2

Frequency Distribution



Procedure 3

Year	Survivors	Non-Survivors	Avg Beak Depth of Survivors (mm)	Avg Beak Depth of Non-Survivors (mm)
1976	100	0	9.39	NA
1977	50	50	9.67	9.11
1978	23	77	9.83	9.26
1979	18	82	10.01	9.26
1980	7	93	9.86	9.36
1981	3	97	9.72	9.38
1982	0	100	NA	9.39

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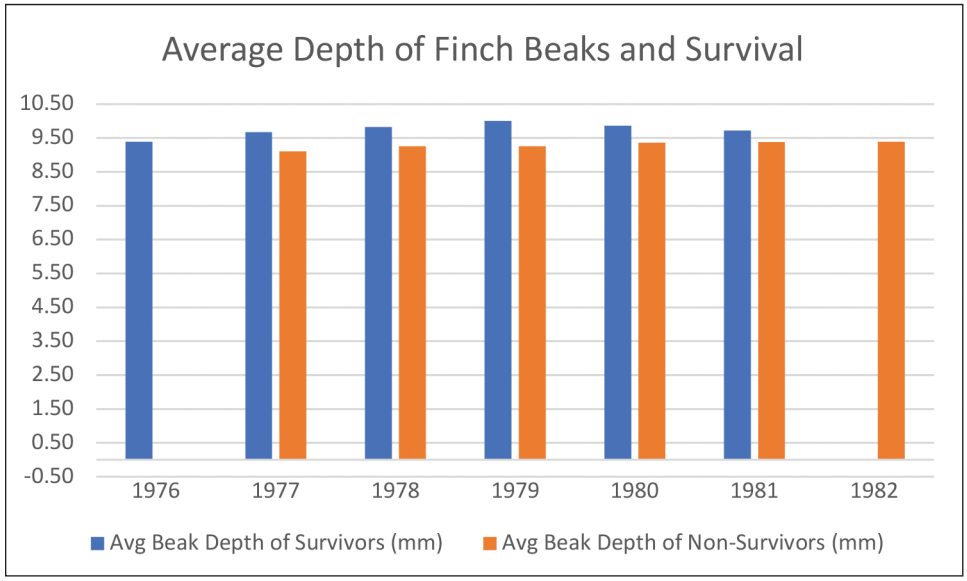
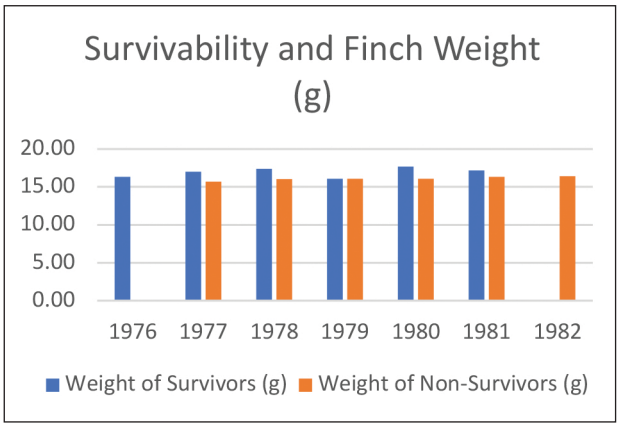
Procedure 4



Procedure 5

Additional Variables
Weight

Year	Weight of Survivors	Weight of Non-Survivors
1976	16.35	NA
1977	16.99	15.71
1978	17.38	16.05
1979	16.06	16.08
1980	17.68	16.06
1981	17.19	16.35
1982	NA	16.41



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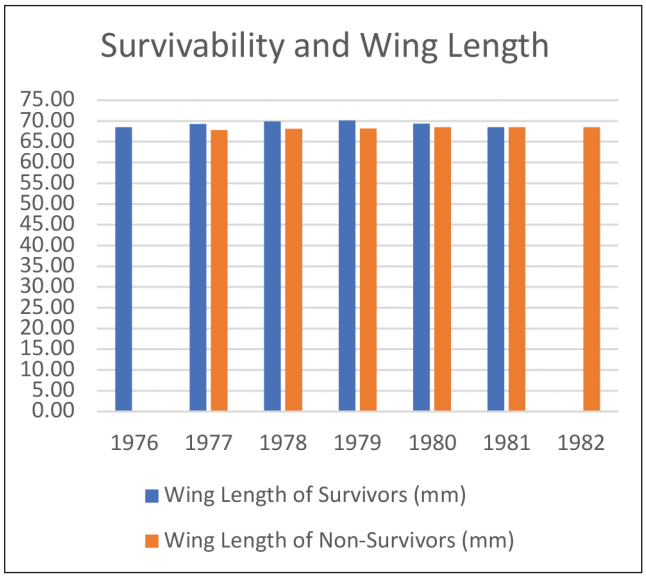
Procedure 5 (continued)

Additional Variables

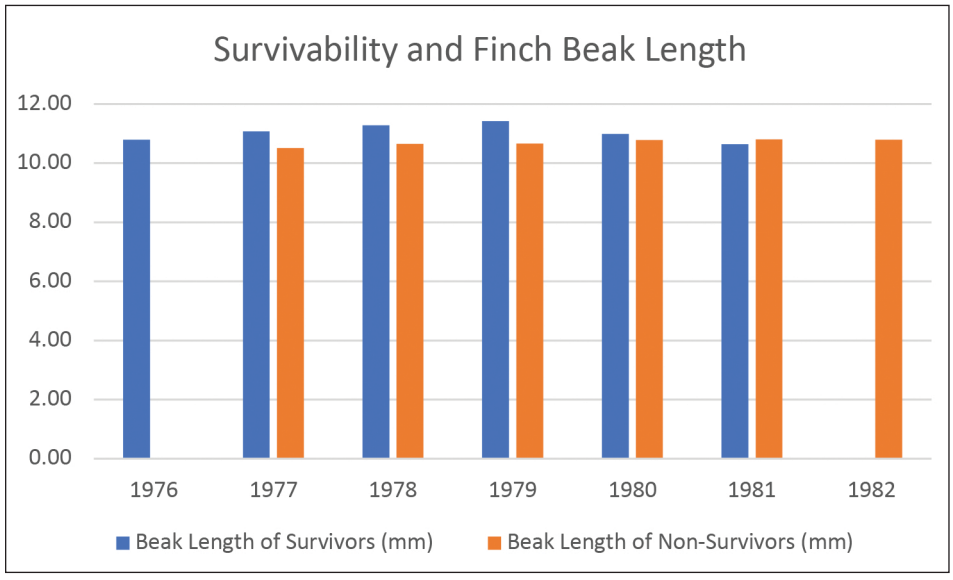
Wing Length

Year	Wing Length of Survivors	Wing Length of Non-Survivors
1976	68.54	NA
1977	69.30	67.79
1978	69.90	68.16
1979	70.15	68.19
1980	69.40	68.48
1981	68.54	68.54
1982	NA	68.54



Beak Length

Year	Beak Length of Survivors	Beak Length of Non-Survivors
1976	10.79	NA
1977	11.07	10.51
1978	11.28	10.65
1979	11.42	10.66
1980	10.99	10.78
1981	10.64	10.80
1982	NA	10.79



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Analysis and Discussion

1. Knowing the drought occurred in 1977, interpret the frequency distribution histogram of survival data.
   In 1977, 50% of the birds died; 1978 also showed a large decrease in finch population. From 1979 to 1981, birds within the 100-bird sample continued to die within their expected life span. (You may wish to add statistical calculations to this question.)

2. Knowing the drought occurred in 1977, interpret the frequency distribution histogram of beak depth and survival data.
   The birds that continued to survive had a noticeably larger beak depth. Increased beak depth for survivors is true for every year past 1977 for which data was supplied. (You may wish to add statistical calculations to this question.)

3. Using your frequency distribution histograms as evidence, make a claim about the evolutionary trend in beak depth.
   It appears that birds with deeper beaks were better able to survive after the drought. Since birds with deeper beaks survived every year past 1977, they could reproduce and potentially pass on their genes for deeper beaks. The evolutionary trend appears to favor finches with deeper beaks.

4. Using your frequency distribution histograms as evidence, make a claim about the evolutionary trend and adaptations in medium ground finches that make those birds better able to survive and reproduce during a drought period.
   Answers will vary depending on which additional variables students select. Generally, the additional variables did not show strong evidence of impacting survival, so beak depth is the trait driving the evolutionary trend. (You may wish to add statistical calculations to this question.)

5. Assuming there are no droughts, predict the average depth of finch beaks. Use your data to justify your prediction.
   The average beak depth of the surviving finches after the 1977 drought is 9.82 mm, so I would expect that those birds continued to reproduce and pass on the genes for a deeper beak. The range of average beak depth after the drought was 9.67 mm to 10.01 mm, with the largest beak depth occurring in 1979. In subsequent years the beak depth decreased slightly. (You may wish to have students generate a line graph and calculate the slope of the best fitting line, or regression line, to predict beak depth.)

References

Grant, P. 1986. *Ecology and Evolution of Darwin's Finches*. Princeton University Press.

Grant, Peter R., and B. Rosemary Grant. 2014. *40 Years of Evolution: Darwin's Finches on Daphne Major Island*. Princeton University Press.

TEACHER NOTES